EPC-1800 Series

EPC-1800 Series User Manual

Version: V1.02013S03

To properly use the product, read this manual thoroughly is necessary.

Part No.: 81-00EPC10-012

Revision History

Date	Revision	Description
2013/9/09	1.0	Document Creation
2014/09/15	1.1	1. Modify the description about COM port settings. 2. Add contents about EPC-1820, EPC-1801 and EPC-1821

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Electrical safely

- To prevent electrical shock hazard, disconnect the power cable from the electrical outlet before relocating the system.
- When adding or removing devices to or from the system, ensure that the power cables for the devices are unplugged before the signal cables are connected. Disconnect all power cables from the existing system before you add a device.
- Before connecting or removing signal cables from the motherboard, ensure that all power cables are unplugged.
- Seek professional assistance before using an adapter or extension card. These devices could interrupt the grounding circuit.
- Make sure that your power supply is set to the voltage available in your area.
- If the power supply is broken, contact a qualified service technician or your retailer.

Operational safely

- Please carefully read all the manuals that came with the package, before installing the new device.
- Before use ensure all cables are correctly connected and the power cables are not damaged. If you detect any damage, contact the dealer immediately.
- To avoid short circuits, keep paper clips, screws, and staples away from connectors, slots, sockets and circuitry.
- Avoid dust, humidity, and temperature extremes. Do not place the product in any area where it may become wet.
- If you encounter technical problems with the product, contact a qualified service technician or the dealer.

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1. Introduction

Utilizing the DMP® Vortex86DX chipsets, EPC-1800 series is a compact size and powerful PAC (Programmable Automation Controller). EPC-1800 provides features including a Motionnet master, a USB interface, 10/100T Ethernet LAN port and a local DIO interface.EPC-1800 with its fanless design offers noise-free, ultra reliable operating in the most demanding of industrial environments.
Motionnet is a high-speed serial communication system, a digital serial control interface for communication between host algorithm and axis-controllers, input/output (I/O) devices and other devices. The EPC-1800 is an ideal system for industrial automation, machine automation and motion control markets.

1.1. Overview

Figure 1-1: overview of the EPC-1800

1.2. Hardware Specifications

CPU	• DMP Vortex86DX 800MHz
Memory	• SDRAM 256MB DDR2
Operating System	• WinCE 5.0 (softPLC version) • WinCE 6.0 (programming version)
D-SUB Male Connector	EPC-1800: D-SUB 26 Male Connector x1 • RS422/RS485 (COM1) • RS232_9P (COM2) • RS232_3P (COM3) • RS232_3P (COM4) EPC-1801 & EPC-1821 • RS232_3P (COM1) • RS422/RS485 (COM2)
USB	• 1 x USB 2.0
Motionnet	• Motionnet Master x 1 (EPC-1800, EPC-1801) • Motionnet Master x 2 (EPC-1821)
Ethernet	• 1 x RJ45 for 10/100T based LAN
Power Requirements	• 24V DC /300mA • Power consumption: 5W
DIO (Isolation 2.5KVDC)	• 4-channel input (EPC-1800) • 8-channel input/8-channel output (EPC-1801, EPC-1821)
Storage	• 2GB onboard flash memory (with operating system occupied)

1.3. Motionnet Compatible Devices

EPC-1800 equipped Motionnet chipsets which is designed for users to quickly and easily develop applications, such as motion control and controls of I/O. EPC-1800 and EPC-1801 have 1 Motionnet master and EPC-1821 has 2 Motionnet masters equipped. Motionnet is a new series of products designed for versatile automation applications, especially with motion control requirements. The built-in Motionnet will be introduced later.

2. Dimensions and Interfaces

EPC-1800 series provides necessary input/output (I/O) interfaces. Besides often used serial communication ports, there are user friendly interfaces including LAN and USB. In this section, the function and pin definition of these interfaces will be illustrated.

2.1. Mechanical dimensions for all types

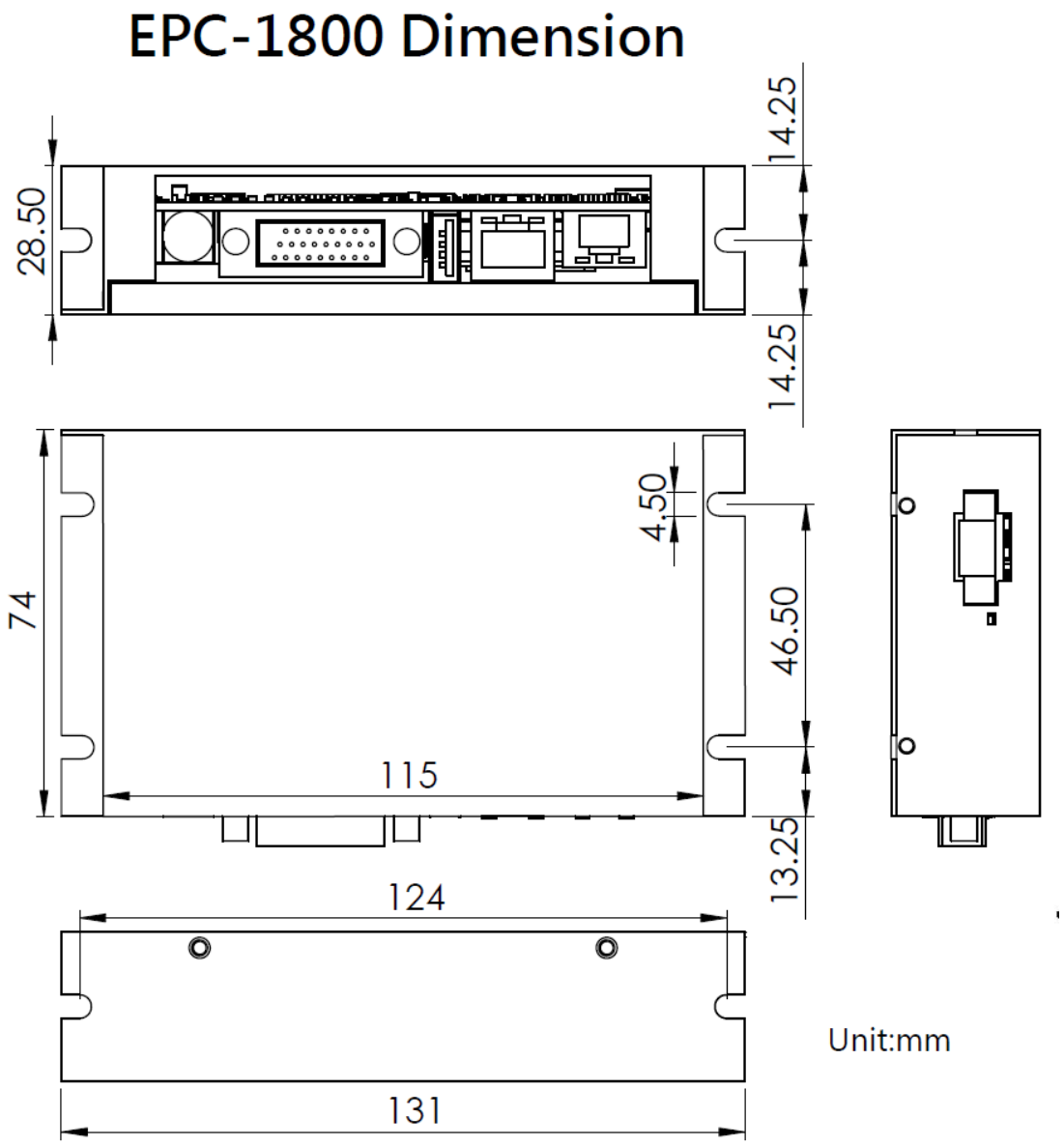


Figure 2-1: dimensions

2.2. Interfaces

The I/O interface arrangement of EPC-1800 and EPC-1801 are introduced by the following figures.

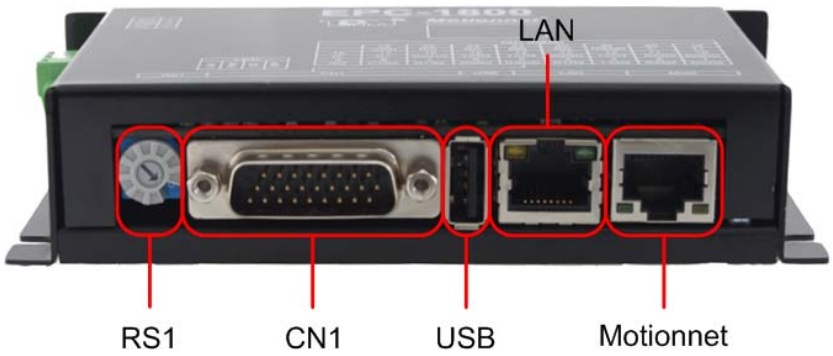


Figure 2-2: main interfaces of EPC-1800 and EPC-1801

Figure 2-3: side interfaces of EPC-1800 and EPC-1801

The I/O interface arrangement of EPC-1821 is introduced by the following figures.

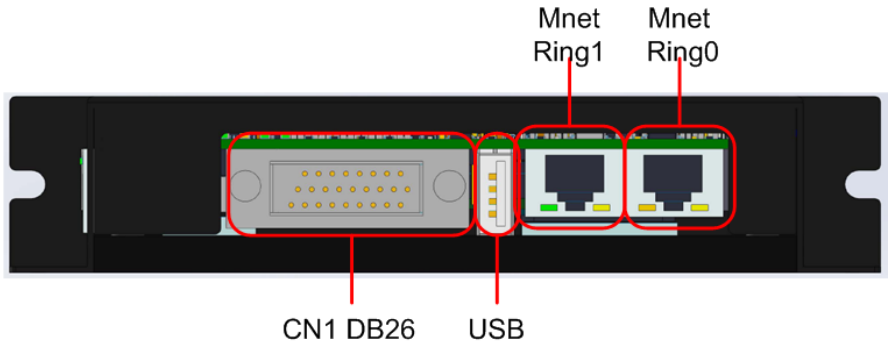


Figure 2-4: main interfaces of EPC-1821

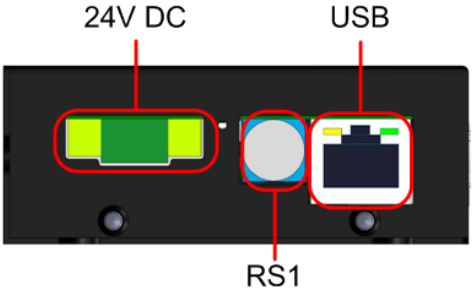


Figure 2-5: side interfaces of EPC-1821

2.3. Pin Assignment for Each Connector

In the following subsections, the pin assignment for each connector will be introduced.

2.3.1. CN1 of EPC-1800

The CN1 26-pin definition of EPC-1800 is shown as below:

Pin No.	Definition	Description	Pin No.	Definition	Description
1	DCD2	Data carrier detect	14	RXD4	4th RS232 RX
2	RXD2	RX	15	TXD4	4th RS232 TX
3	TXD2	TX	16	DGND	4th RS232 DGND
4	DTR2	Data terminal ready	17	R+	RS422/485 R+
5	DGND	1st RS232 DGND	18	R-	RS422/485 R-
6	DSR2	Data set ready	19	T+	RS422/485 T+
7	RTS2	Request to send	20	T-	RS422/485 T-
8	CTS2	Clear to send	21	DGND	RS422/485 DGND
9	RI2	Ring indicator	22	DI3	Digital input 3
10	DGND	DGND	23	DI2	Digital input 2
11	RXD3	3rd RS232 RX	24	DI1	Digital input 1
12	TXD3	3rd RS232 TX	25	DI0	Digital input 0
13	DGND	3rd RS232 DGND	26	GND	DI ground

Table 2-1: pin assignment of DI/O interface of EPC-1800

Digital GPIO input signal circuit in SINK mode (NPN) is illustrated as follows.

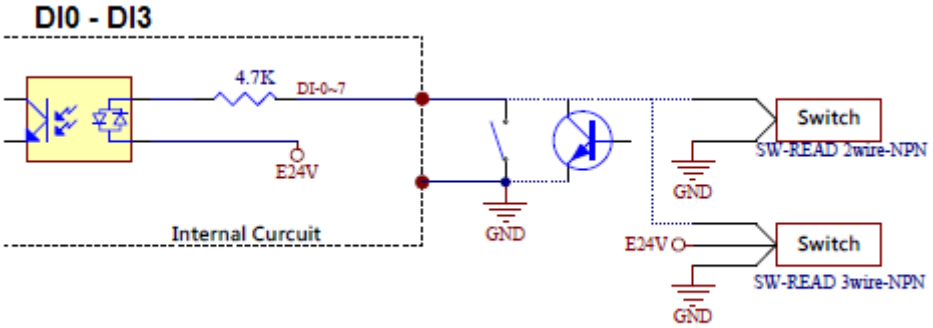


Figure 2-6: DI NPN logic circuit of EPC-1800

2.3.2. CN1 of EPC-1801 and EPC-1821

The CN1 26-pin definition of EPC-1801 andEPC-1821 is shown as below:

Pin No.	Definition	Description	Pin No.	Definition	Description
1	DO0	Digital output 0	14	DI6	Digital input 6
2	DO1	Digital output 1	15	DI5	Digital input 5
3	DO2	Digital output 2	16	DI4	Digital input 4
4	DO3	Digital output 3	17	R+	RS422/485 R+
5	DO4	Digital output 4	18	R-	RS422/485 R-
6	DO5	Digital output 5	19	T+	RS422/485 T+
7	DO6	Digital output 6	20	T-	RS422/485 T-
8	DO7	Digital output 7	21	option	Grounding for RS422 Else for RS485
9	GND	Ground	22	DI3	Digital input 3
10	GND	Ground	23	DI2	Digital input 2
11	RXD3	RS232 RX	24	DI1	Digital input 1
12	TXD3	RS232 TX	25	DI0	Digital input 0
13	DI7	Digital input 7	26	GND	Ground

Table 2-2: pin assignment of DI/O interface of EPC-1801 and EPC-1821

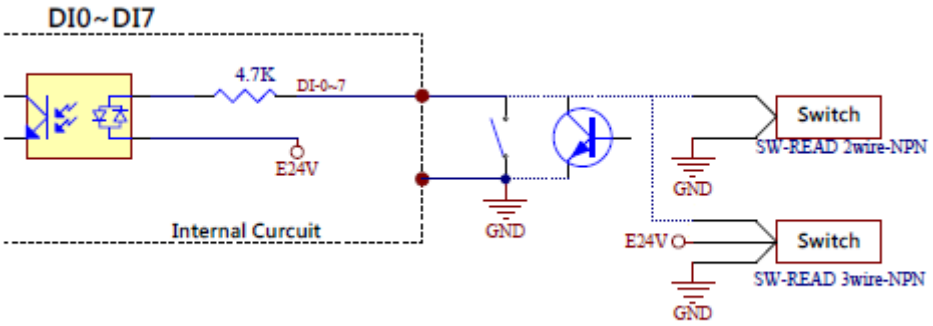


Figure 2-7: DI NPN logic circuit of EPC-1801 and EPC-1821

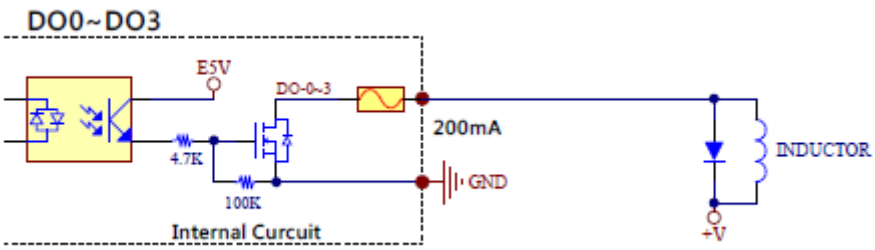


Figure 2-8: DO0~DO3 NPN logic circuit of EPC-1801 and EPC-1821

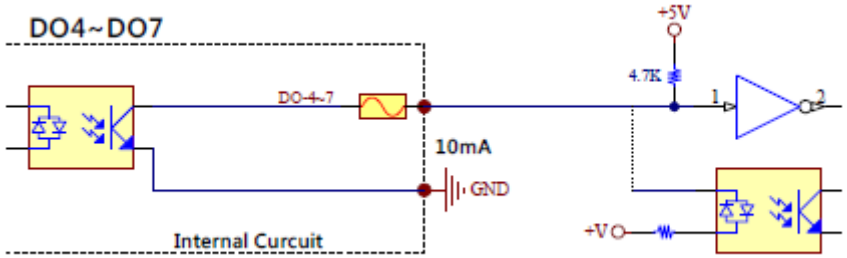


Figure 2-9: DO4 ~ DO7 NPN logic circuit of EPC-1801 and EPC-1821

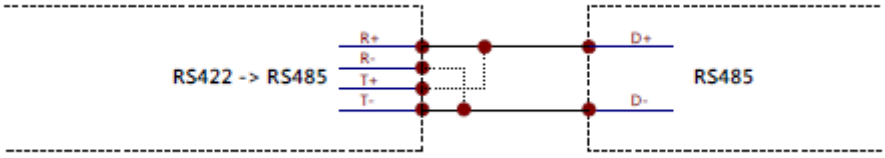
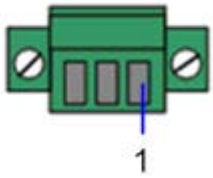


Figure 2-10: RS422/RS485 wiring illustration of EPC-1801 and EPC-1821

Note that the “option” signal needs to be connected to GND for using of RS422.

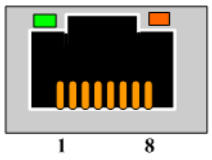
2.3.3. Side 24V DC Input



Pin No.	Definition	Description
1	24V	24V DC power input
2	GND	Ground
3	FG	Frame ground

Table 2-3: power connector pin definition

2.3.4. Motionnet Interface



Pin	Pin Mark	Pin Description
1	NC	Reserved
2	NC	Reserved
3	RS485+	Motionnet protocol +
4	NC	Reserved
5	NC	Reserved
6	RS485-	Motionnet protocol -
7	NC	Reserved
8	NC	Reserved

Table 2-4: pin definition of the Motion Ring

2.3.5. RS1 – Rotary switch

The rotary switch on the EPC-1800 series controller is for specifying the application executable to be brought up when system is up and running. 0 is default and no application will be running. 1 is for MyConfig server and 2 is for MyLink server. 3 and 4 are reserved for MULTIPROG related settings. 5 and 6 are available for users to set when the user application needs to be running when system is up. Via MyConfig can configure the auto execution settings.

RS1 value	**Operating Mode**	**Details**
0	MyConfig Server Mode	Set default IP address 192.168.1.100
1	MyConfig Server Mode	
2	MyLink Server Mode	
3	Backup	Backup whole system to CF card
4	Restore	System restore from CF card
5	User define	Set user application via MyConfig
6	User define	Set user application via MyConfig
7	KW Mode + Modbus Slave over RTU	Cold
8	KW Mode + Modbus Slave over RTU	Stop
9	KW Mode + Modbus Slave over RTU	Warm
A	KW Mode + Modbus Slave over TCP	Cold
B	KW Mode + Modbus Slave over TCP	Stop
C	KW Mode + Modbus Slave over TCP	Warm
D	KW Mode	Cold
E	KW Mode	Stop
F	KW Mode	Warm

3. Motionnet Introduction

3.1. What Is Motionnet?

Motionnet is a super high-speed serial communication system. The G9000 devices provide input/output (I/O) control, motor control, CPU emulation and message communication with high speed serial communications (up to 20Mbps) all of which are required by current Factory Automation techniques. Motionnet always transfers 4 bytes of data in 15.1μsec using cyclic communication to control input and output. While this data is being transferred, it can communicate a maximum of 256 bytes, such as motor control data, and the LSI controls the data transmission using interrupts. Communication times can be calculated using formulas, allowing users to see that Motionnet guarantees the real-time oriented support needed by FA industries.

3.2. Motionnet Functions

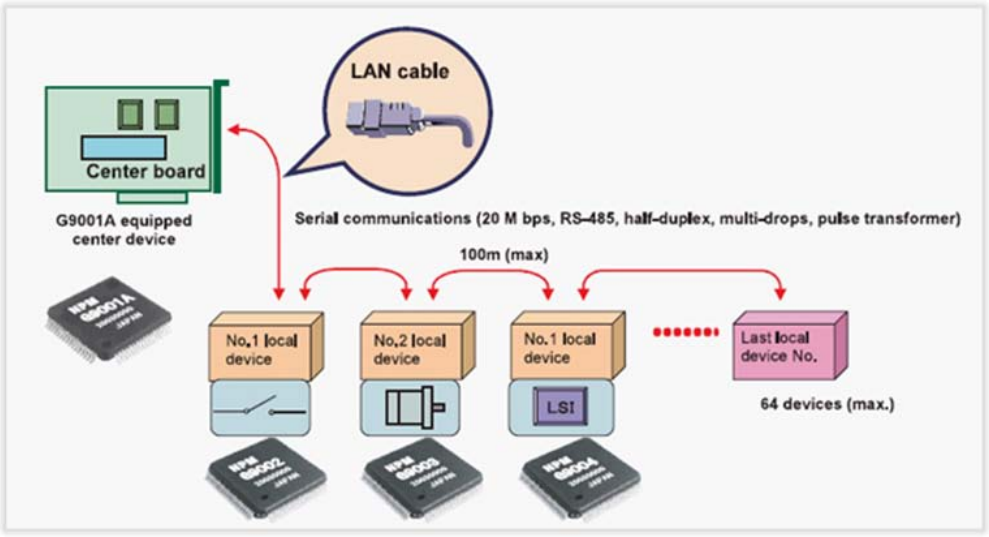


Figure 3-1: Motionnet system architecture

- Provides a communication protocol based on the RS485 standard.
- Can communicate variable length of data from 1 to 128 words (when a 16-bit CPU is used)
- An LSI central device (G9001) controls the bus.
- I/O wiring can be greatly reduced by using a G9002 I/O device.
- Motor control wiring can be reduced by using a G9003 PCL.
- Using a G9004 CPU emulation device reduces the wiring for general devices connected to a CPU. Data can be exchanged between CPUs by changing the G9004 mode.
- New devices can be added to the system on the fly.
- Systems can be isolated using pulse transformers.
- Transfer speed up to 20 Mbps.

- Maximum 64 slave devices for each serial line on a master device.I/O control of up to 256 ports (2048 points), motion control of up to 64 axes, and LSI control of up to 128 devices.
- I/O and status communication time for each device when inputting/outputting and reading status data for each device, the system automatically refreshes the center device RAM each communication cycle.(Cyclic communication: 15.1 μsec./local device)When 32 local devices are connected (1024 points of I/O): 0.49 msec. When 64 local devices are connected (2048 points of I/O): 0.97 msec.
- Data communication time cyclic communication can be interrupted with a command from the CPU. Data communication time: 19.3 μsec. to send or receive 3 bytes (e.g. when writing feed amount data to the G9003).Data communication time: 169.3 μsec. to send or receive 256 bytes.
- Serial communication connection cable. Multi-drop connections using LAN cables or dedicated cables. Total cable length of one line: 100 m (20 Mbps/32 local boards) (10 Mbps/64 local boards).Cable length between local boards: 0.6 m or longer.

3.3. Advantage of Motionnet

- It is possible to connect from center to terminal controller parts by one cable.

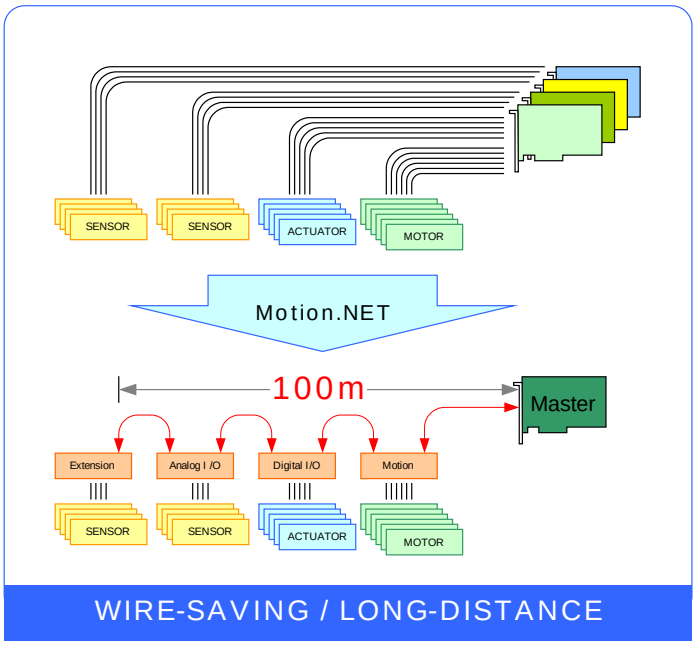


Figure 3-2: wire-saving and long-distance support

- In cyclic communication, a communication cycle is as follows when a 20 Mbps speed is selected.

Number of local devices	Communication cycle	Remarks
8	0.12 ms	If all of the local devices connected are I/O devices, 256 I/O points can be used.
16	0.24 ms	If all of the local devices connected are I/O devices, 512 I/O points can be used.
32	0.49 ms	If all of the local devices connected are I/O devices, 1024 I/O points can be used.
64	0.97 ms	If all of the local devices connected are I/O devices, 2048 I/O points can be used.

If a different number of local devices are connected, or when the communication cycle is interrupted by data communications, refer to the calculation formulas in the user's manual to calculate the time latency.

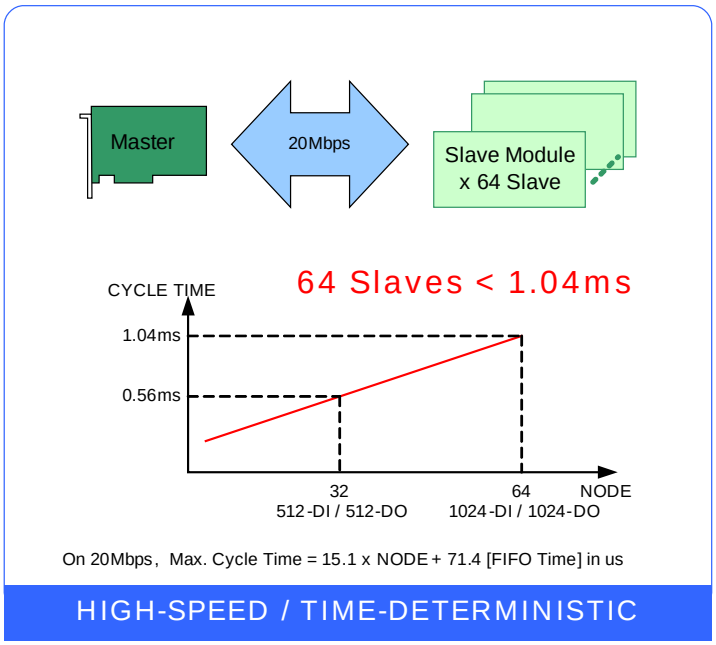


Figure 3-3: high-speed and time deterministic support

4. Software Utilities

There are two software utilities provided to help users easily make use of EPC-1800.

1. MyConfig – for configuring the settings in EPC-1800.
2. MyLink – for diagnosing and testing functionality of Motionnet modules.

4.1. MyConfig

MyConfig is a software utility designed for EPC-1800. Besides providing basic hardware information, MyConfig also supports online updates so that users can set and view the hardware status through Ethernet.

Recommended Hardware Requirement
PC Hardware: PC or laptop with Intel Centrino or above CPU
Memory: 1GBRAM
OS: Windows XP or Win7
LAN card: RJ-45 10/100/1000 Mbps

Software Installation
EasyPAC needs 2 files: MyConfigSvr.exe and EZPACSDK.dll
PC needs 1 file: MyConfig.exe

4.1.1. Server on EPC-1800 series

Before powering up EPC-1800, please make sure the SW1 is switched to position 1. PC is supposed to have the same network section as EPC-1800 (IP address: 192.168.1.100) when the network cable is hooked up. If these two settings are correct, we can power up the EPC-1800. It will beep an alert sound if the system is successfully brought up and MyConfigSrv.exe will be started automatically. If there is no beep for a while, that means that there is Ethernet failure or the IP address is in conflict with someone else.

4.1.2. PC side settings

4.1.2.1 Login

Users can login MyConfig with EPC-1800 IP address and password. MyConfig provides two kinds of login accounts which have different privileges. The default password for an administrator is **admin** and the default password for a guest is **guest**. The password canbe updated after the initial login. The administrator has the privilege to view and change settings, and the guest can only view the current settings. Below illustrates the case of an administratorinitially logging in with rotary switch set to 0, and using default IP address 192.168.1.100.

Figure 4-1: MyConfig login page

After logging in, there are 6 tabs – PAC info, Auto Execute, Update, AES code, Modbus Parameters and About MyConfig.

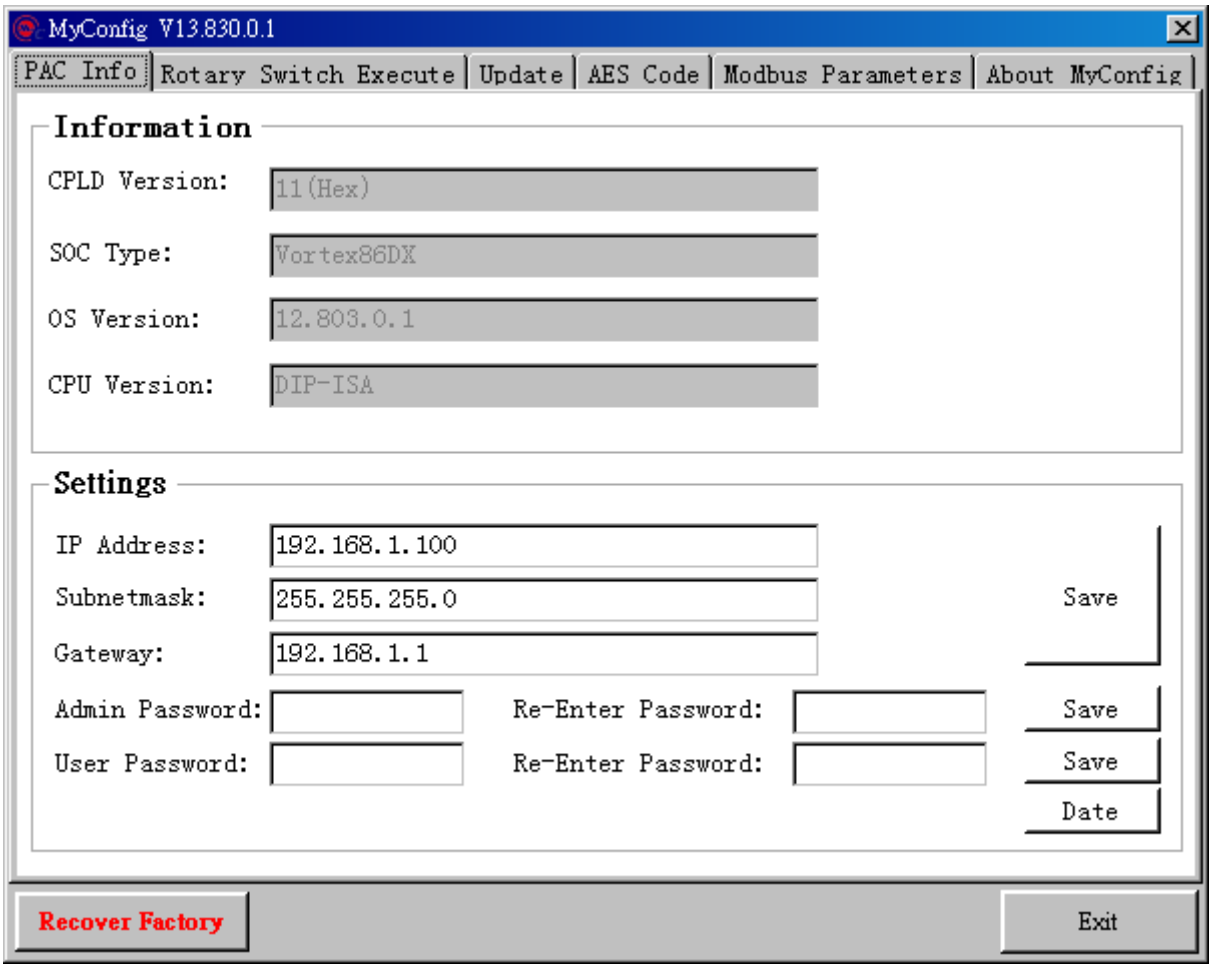


Figure 4-2: system information of EasyPAC

4.1.2.2 PAC Info

Users can see the EPC-1800 basic hardware information at the top half of the page. At the bottom half, users can set up IP addresses, subnet masks, gateways, admin passwords and guest passwords.

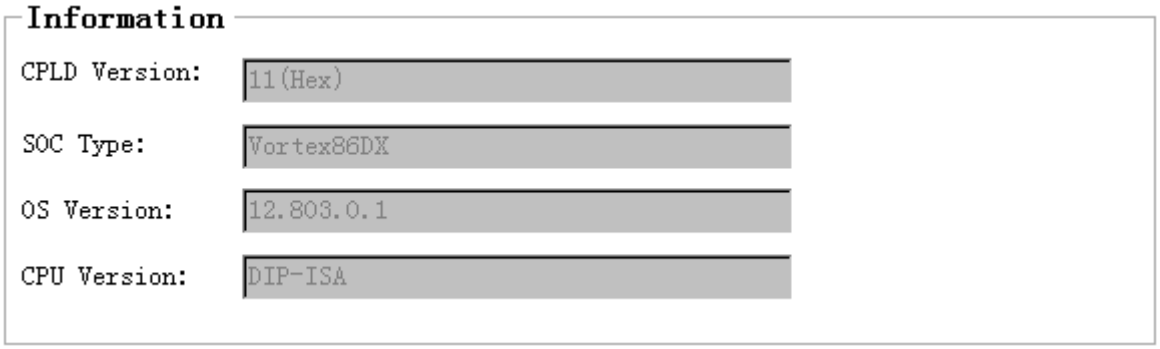


Figure 4-3: Hardware basic information

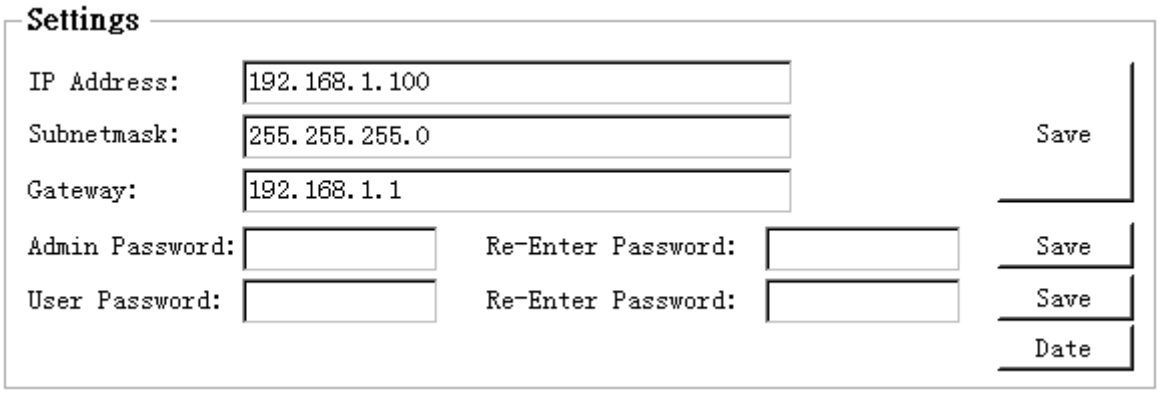


Figure 4-4: change settings of IP, subnet mask, gateway, admin and guest password

Note that only if the user is in the same network section can they change the EPC-1800 IP address. The IP address, subnet mask and gateway settings can be saved if the “Save” button is hit. This save will take effect after restarting the system. The admin and guest password will change immediately when new a password is input and “Save” button is pressed.

4.1.2.3 Update

It provides an online software update. Please make sure the PC is connected to the internet before an online update. If the “Check for Updates” button is pressed, it will show up the software versions on EPC-1800 and user’s PC at the top half. At the bottom half it shows the latest software versions provided from TPM.

Figure 4-5: connect to FTP server

The upper frame shows information including 1: PC side version, 2: EasyPAC side version and 3: the latest version in FTP site. If the older version displays “?.?”it means that there is one or more components which do not match with the newer version ones.

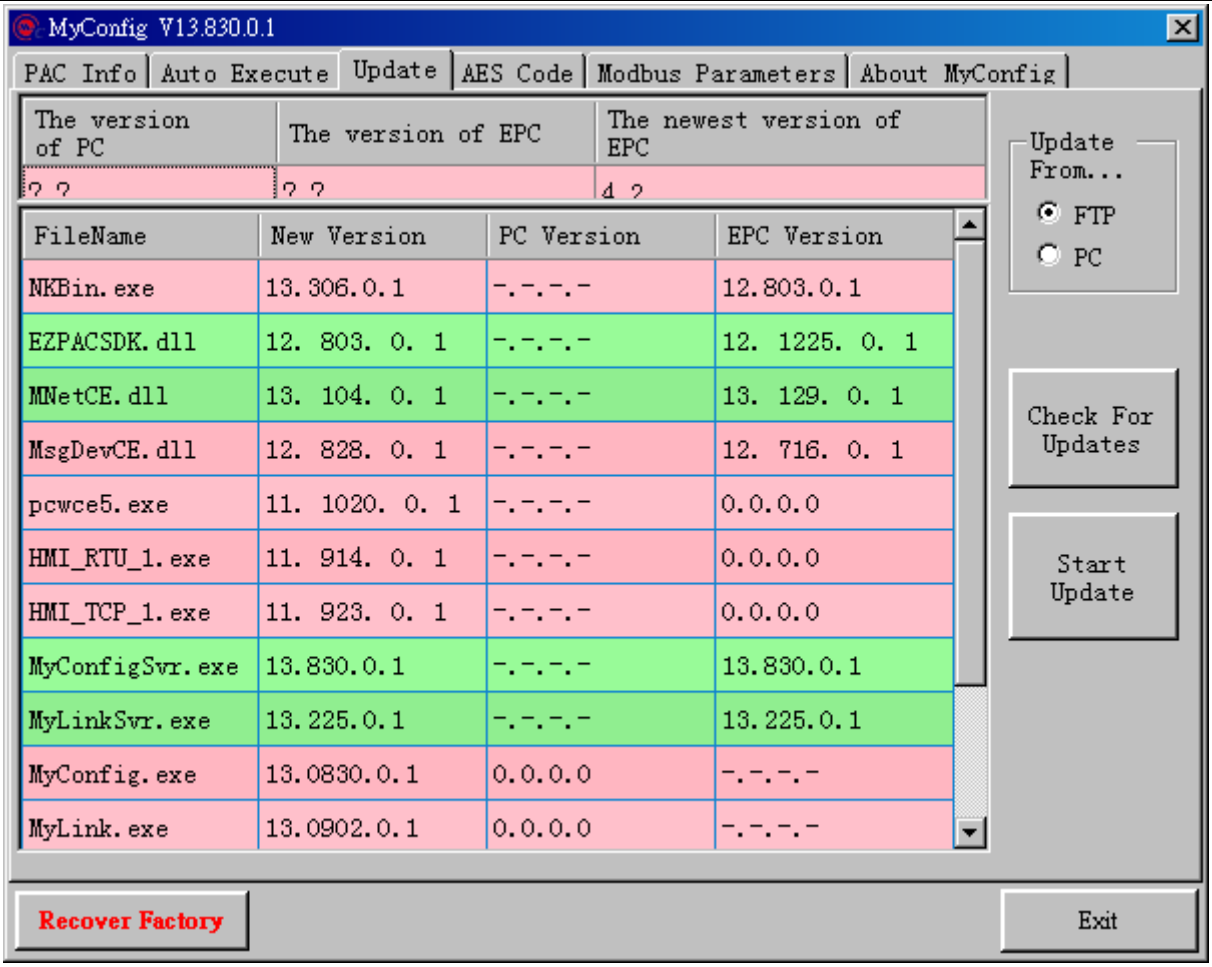


Figure 4-6: update software page

In this “Update” tab, it would show up the software versions that are out of date. There is also a hint message informing when software needs to be updated. After the OK button is pressed, MyConfig starts connecting to the FTP server and downloading files.

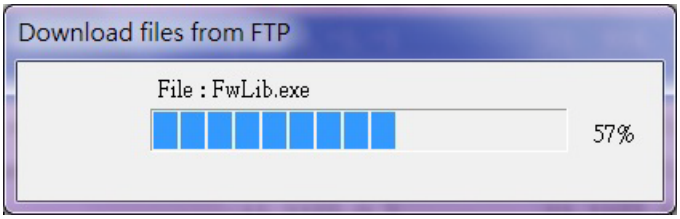


Figure 4-7: download from FTP

Upload to EPC-1800.

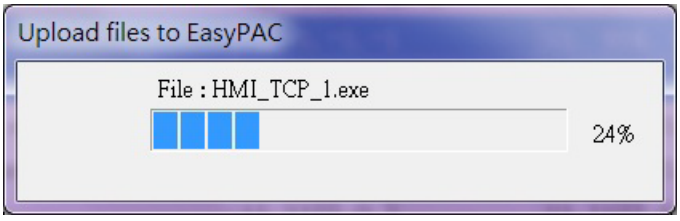


Figure 4-8: update to EasyPAC

When select files need to be updated press the “Start Update” button and it will start updating and a pop-up progress bar, like the one below, will appear.

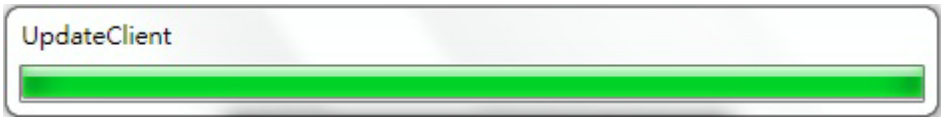


Figure 4-9: progress bar of software updating

If the update includes PC only, the following dialog box will pop up.

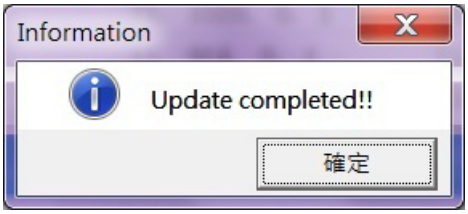


Figure 4-10: update complete dialog

If the software update completes including EasyPAC, it will pop up a dialog box saying the update completed. EPC-1800 needs to reboot to apply new software.

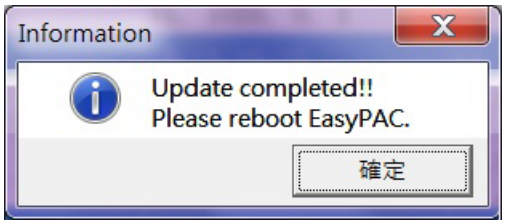


Figure 4-11: update complete dialog

4.1.2.4 AES Code

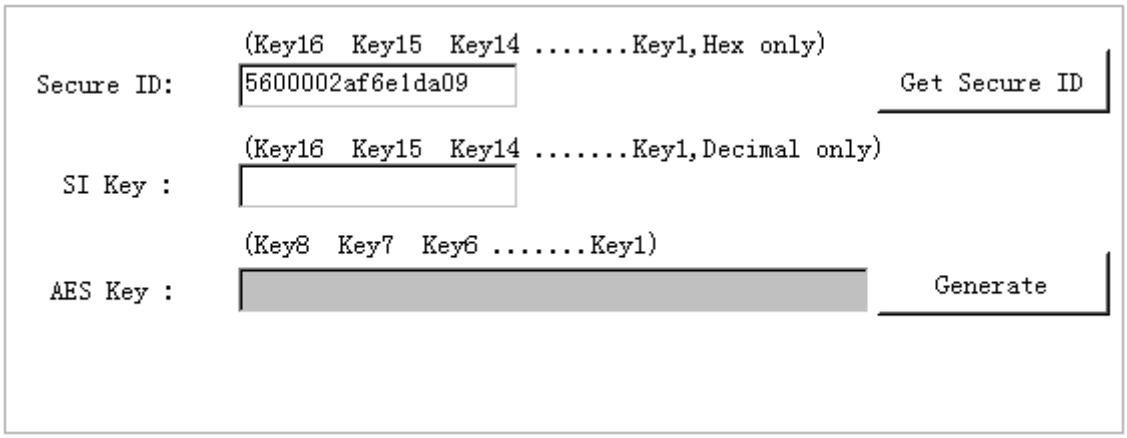


Figure 4-12: dialog window for generating AES key

Secure ID: display the hardware id of the EPC-1800. Moreover, the system integrator caninput the hardware id of other EPC-1800 in the “Secure ID” text box to generate the corresponding AES key.
EPC-1800provides an AES key encryption mechanism to protect our customers. The SI key is supposed to be 16 numeric digits. If the SI key is not 16 digits or it contains non-numeric digits, an error message will show up as the figure below.

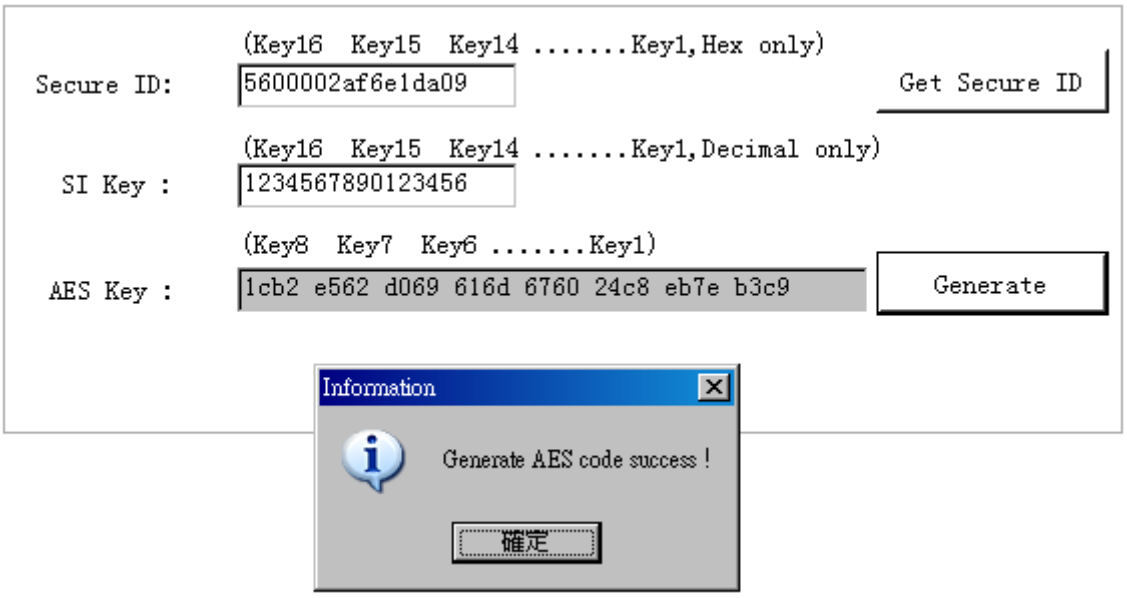


Figure 4-13: insufficient digits

4.1.2.5 Modbus Parameter

The “Modbus Parameters” page lets users edit Modbus related parameters for KW applications of EasyPAC. Modbus requires settings of slave ID, TCP and RTU parameters. MyConfig provides sets of default settings in advance. Users can change the settings and press the “Save Settings” button to transmit the settings to EasyPAC.

Next time when users login to MyConfig, the prior settings or the default values will be shown in the Modbus parameters page. Users can always login to check in this page. This page is shown in the following figure.

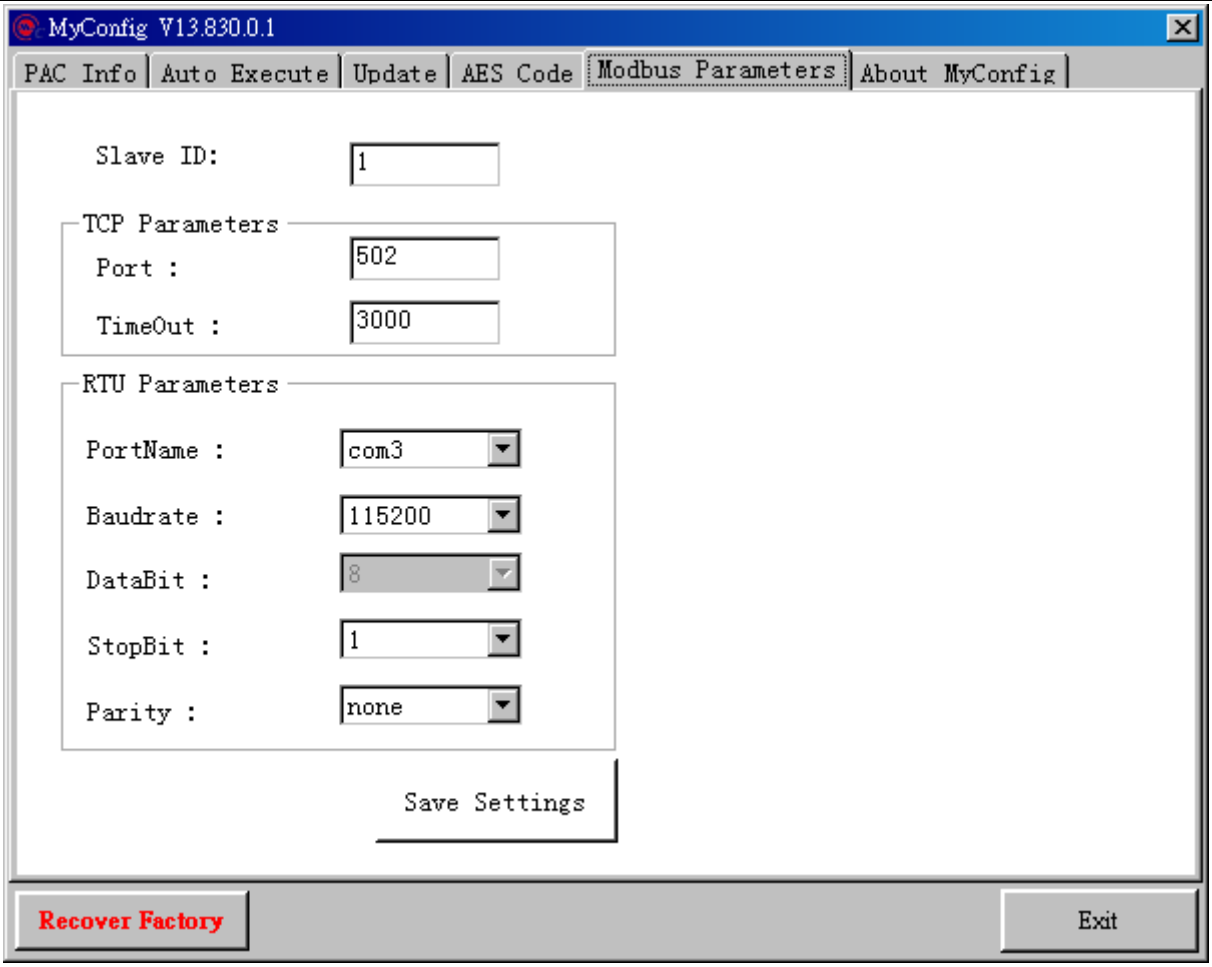


Figure 4-14: setting of Modbus parameter dialog

4.1.2.6 Recover Factory Default Settings

If users forget the changed password of admin or guest, or the changed settings of the IP, Modbus, etc is not working, a solution is to recover the factory settings. The step-by-step recovery from factory settings is as follows:

1. Press the recovery button

and then reboot.
2. The EPC-1800 would roll back to the default IP address: 192.168.0.100. Now we could connect to it with MyConfig.
3. The “PAC info” tab has previous set IP address shown in “Saved IPAddress”.

5. Project Encryption

This chapter is intended to give a brief overview of the project encryption for EPC-1800. The following section will give background information that is necessary to fully understand the functions and how to achieve hardware encryption of the system.

5.1. Benefits

TPM is a development system provider with EPC-1800 as one of the products. System integrators could adapt EPC-1800 as the base system to develop applications for their customers. However, customers could find the top source vendor which is TPM and perhaps, in the worst case, clone the storage in the system and purchase extra systems from TPM directly. In case of customers bypassing the original system provider, which would cut down benefits for the system integrators cooperating with TPM, EPC-1800 introduces a method called project encryption. Through project encryption, the system integrators can lockup certain functionalities or set timers to constrain the system running time. Only the authorized products can be working properly. The authorization is held by one, and only one, system integrator.
With the project encryption technology, the system integrators cooperating with TPM will be tightly coupled in a cooperating relationship, instead of vicious competition to make a win-win partnership.

5.2. AES Brief Introduction

This standard specifies the Rijndael algorithm, a symmetric block cipher that can process data blocks of 128 bits, using cipher keys with lengths of 128, 192, and 256 bits. Rijndael was designed to handle additional block sizes and key lengths; however, they are not adopted in this standard. Throughout the remainder of this standard, the algorithm specified herein will be referred to as “the AES algorithm.” The algorithm may be used with the three different key lengths indicated above, and therefore these different “flavors” may be referred to as “AES-128”, “AES-192”, and “AES-256”.
Since the AES encryption/decryption algorithm is not the main function of EPC-1800, the detailed introduction is not introduced in this manual. Please refer to Wikipedia for more information.

5.3. Functional Architecture

Each EPC-1800 is equipped with an identification chip that has a unique serial number. The unique serial number plays the role as the content for AES algorithm. We will call the unique serial number the “hardware id” from now on. Another key held by the system integrator is called the SI key, used for encryption/decryption for the AES algorithm to make the registration key. The illustration of the making of the registration is as the following figure.

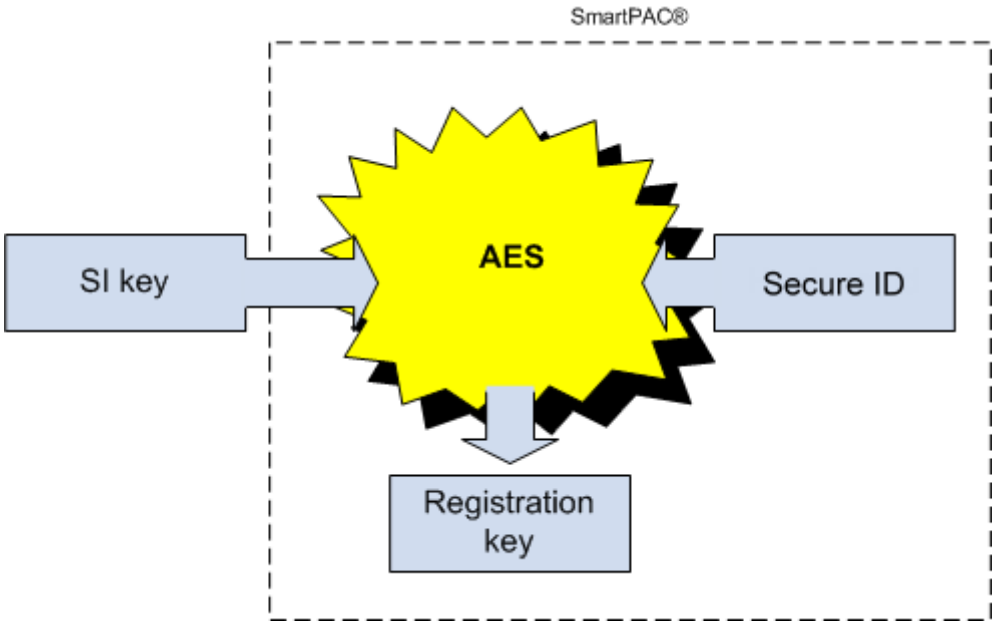


Figure 5-1: generation of the registration key

From the above figure, the hardware id is obtainable within EPC-1800, taken as the content for the AES algorithm. The SI key, hard coded by the system integrator, is the key to calculate the output value and the registration key. The registration key is like the activation code to activate the full functionalities of the EPC-1800 and it is not invertible. Even though the whole data including the registration key could be cloned, the end user or the system integrator's customer cannot obtain the SI key. If an end user wants to buy a replacement from other resources instead of the designated system integrator, it is not doable since the hardware id would be different with the original one. Therefore, the calculated registration key with the original SI key and different hardware id as content would not match so that the specific functionalities could not be working or the system could only run for certain time period.

Once the system integrator gets EPC-1800, a very important thing needed to do is to assign a set of SI key with a byte array of length 8 to it. With this SI key, the system integrator can generate the AES key (byte array of length 16) using the provided function application interface _ezpac_generate_aes_key. This function will be introduced later. The generated AES key should be given to end users as the activation code when the user brings up the system at first time. AnEPC-1800 should check the validity and set the corresponding flag in the FRAM right after the system initialization using function _ezpac_verify_aes_key, _ezpac_write_fram_byte. Hereafter, when the system is brought up, it reads the flag from FRAM. If the read value matches the pre-defined value, the system bypasses the check AES key procedure and operates normally as the system integrator designed. If the values from the designated address in FRAM do not match, the system could only run a certain time or some advanced functions become locked. Only with the correct activation code can you bring the system up with full functionalities and unlimited running time.

6. Software Development Environment

6.1. System Requirements

The sections below describe the system and software requirements for developing EPC-1800 applications. Note that the programming using C/C++/C# needs to check the following settings for the environment. If the programming is through KW MULTIPROG, please refer to MULTIPROG programming manual.

6.1.1. Hardware Requirements

- Processor: 1 GHz
- RAM: 256MB
- Available hard disk space: 3GB

6.1.2. Software Requirements

- Operating system: Microsoft Windows XP or 7
- SDK: Microsoft Visual Studio 2005
  - **Need service pack 1 and .NET compact framework 2.0 service pack 1 installed**

- SDK: Microsoft Visual Studio 2008
  - **Need service pack 1 installed**

  If there are connection problems on online debugging, please copy the 5 online debug files from developing PC to EPC-1800 and try again. Once the files are copied to the specified location on EPC-1800, it will be copied to folder \Windows automatically after restarting the system.

The location of the online debug files would be located at described below.
Windows XP/7 32-bit OS (source):as shown in figure 7-1
C:\Program Files\Common Files\microsoft shared\CoreCon\1.0\Target\wce400\x86*.*.

Windows 7 64 Bit OS (source): as shown in figure 7-1
C:\Program Files (x86)\Common Files\microsoft shared\CoreCon\1.0\Target\wce400\x86*.*.

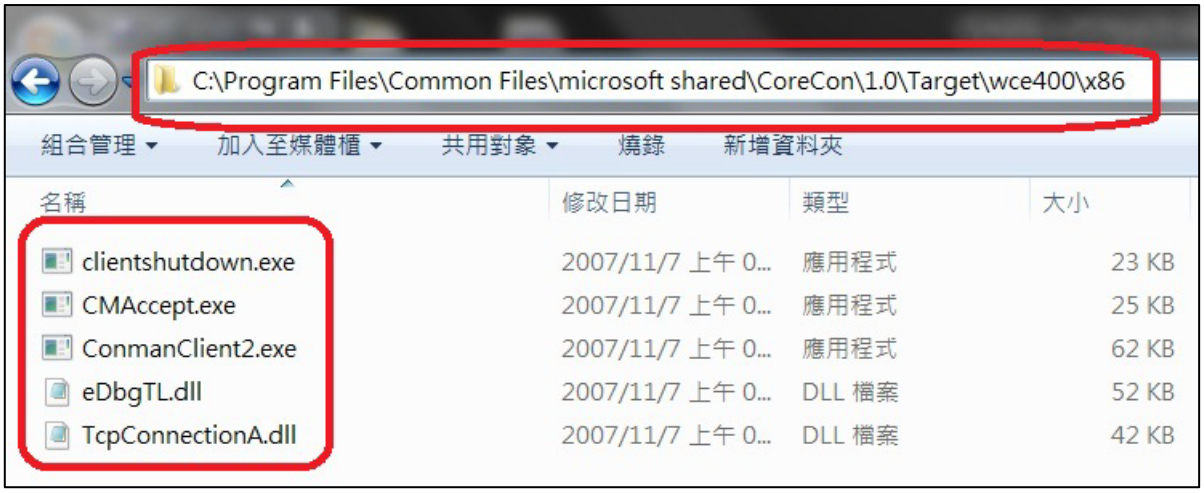


Figure 6-1: file path for remote debugger files

EPC-1800 (destination):
\USB\Project
Transfer the files from PC to EPC-1800 using FTP software. The destination location of EPC-1800 is \USB\Project. The account to log in FTP service of the EPC-1800 is account: **admin** and password: **admin**.

6.2. Online Debugging

Online debugger is a very useful tool when developers are developing their projects. EPC-1800 also provides an online debugger mechanism to help users easily online debug and monitor variables. There are some preliminaries need to prepare of both developing PC and EPC-1800 before starting the online debugging.

6.2.1. Check the Ethernet IP Address of the EPC-1800

Configure the IP address by using MyConfig. In the following instances, 192.168.1.130 is used as an example.
Please make sure the IP address of EPC-1800 and the SDK machine are in the same network subnet. SmartPAC is the server of the running application and connected with the SDK machine to achieve online debugging. The Sequence to establish a connection to the EPC-1800 will be introduced next.

6.2.2. Create a New Project

When create a new EPC-1800 project, please select “Smart Device” → “Windows CE 5.0” as the project type as shown in the follow figure.

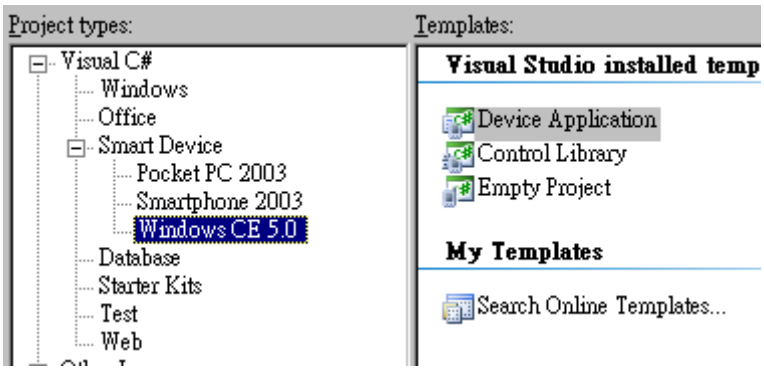


Figure 6-2: select Windows CE 5.0 as the project type

Go to the properties of the project and uncheck the checkbox of "Deploy the latest version of .NET Compact Framework (including Service Packs) as shown below.

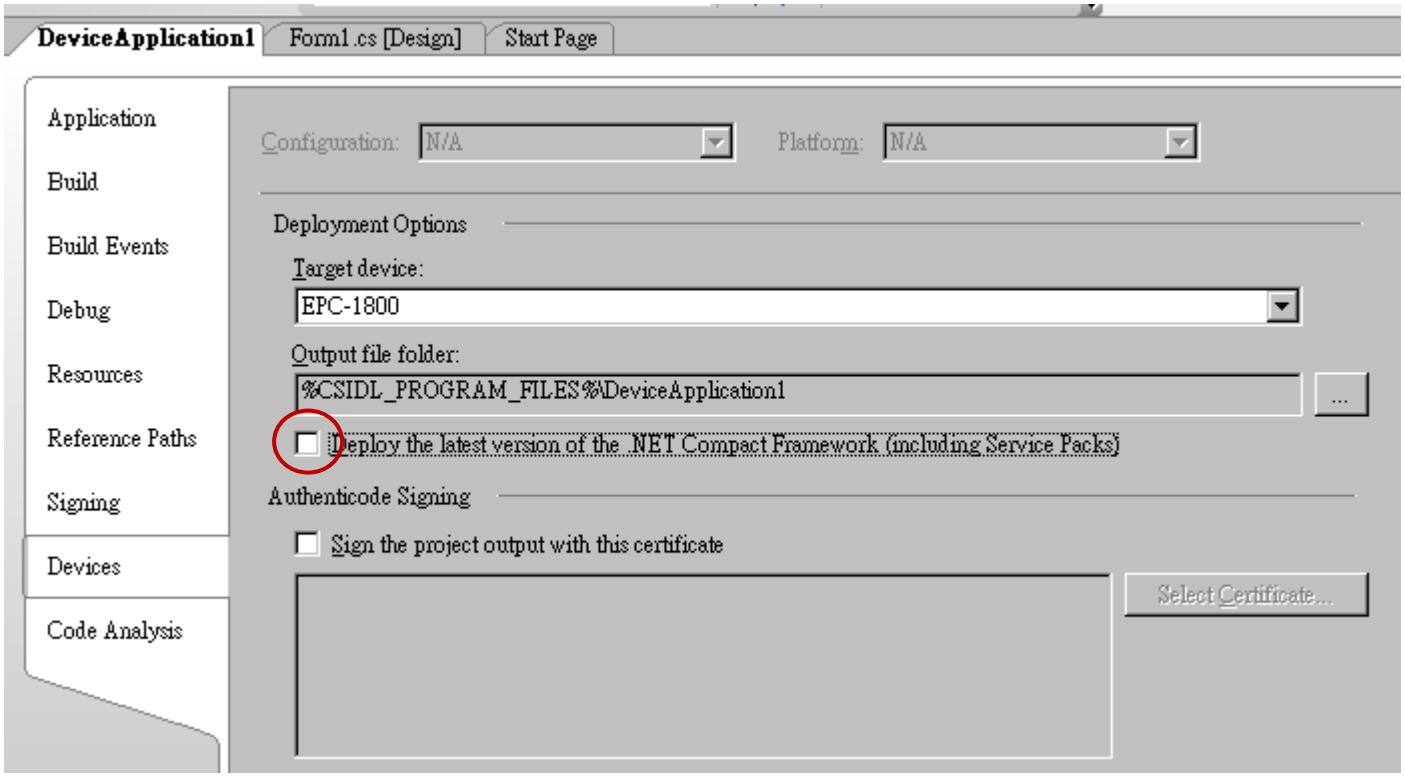


Figure 6-3: uncheck the checkbox highlighted

6.2.3. Connect to EPC-1800

There are several steps to establish a connection to EPC-1800.

1. Open the sample project for EPC-1800.
   Example: C:\TPM\EPC-1800\Samples\VS2005_VC\Platform_demo(VC)\Platform_demo.sln
2. Configure the device option by selecting **Tools → Options** in the function menu.

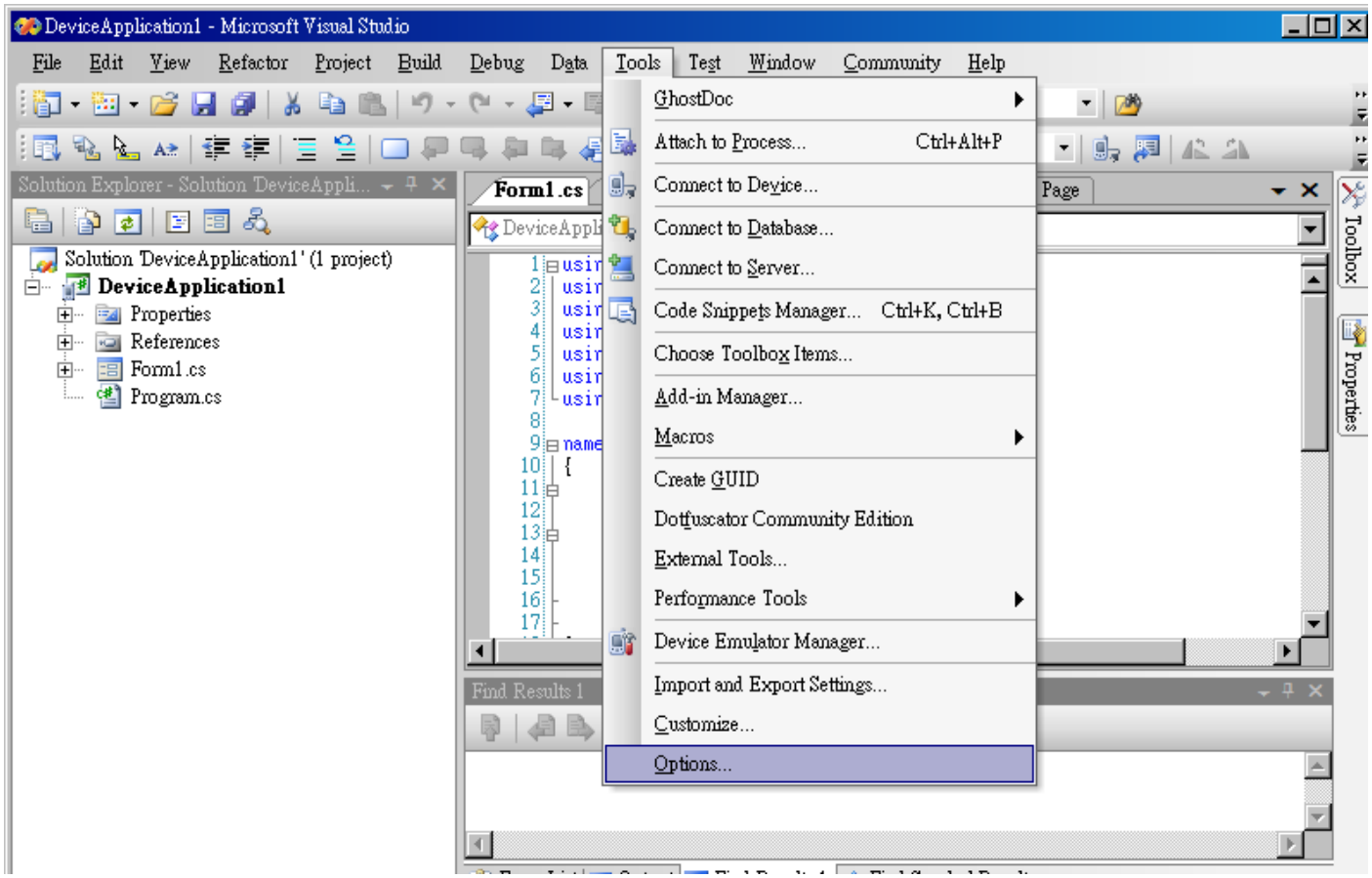


Figure 6-4: tools - options

3. Configure the target device IP address
   It is necessary to configure the target IP address before making a connection. This could be done through "**Device Tools →Devices**" from the option window as the 1st step in Figure 6-5.
4. Select the target device (EPC-1800 for this example) as marked as the 2nd step in Figure 6-5 and hit the "**Properties…**" button as the 3rd step.
5. The EPC-1800 properties dialog will be popped-up. Click the "**Configure…**" button to configure as the 4th step in Figure 6-5.
6. Specify the target IP address and click OK button to finish the configuration process as shown as the 5th and 6th step in Figure 6-5.

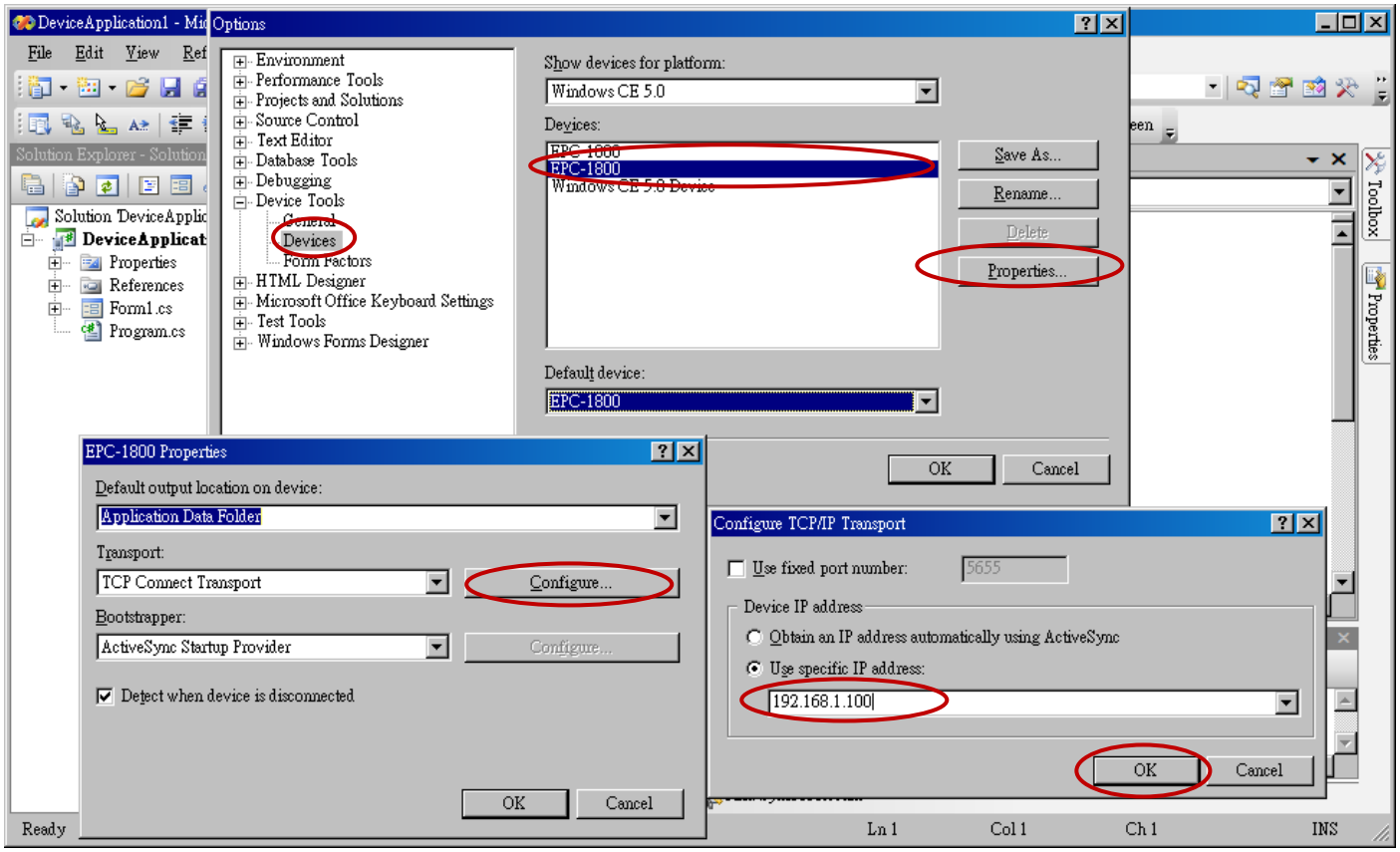


Figure 6-5: step sequence to configure the target device IP address for SDK machine

7. Launch the EPC-1800 debugging service using telnet and execute the following programs in order. There should be 2 telnet consoles launched.
    1. Clientshutdown.exe
    2. ConmandClient2.exe
    3. CMAccept.exe

Note the IP address of the EPC-1800 is configured by MyConfig. The three executables are in the in the folder created in previous section, \USB\Project

8. Connect to EPC-1800 with the sequence in the following figure.

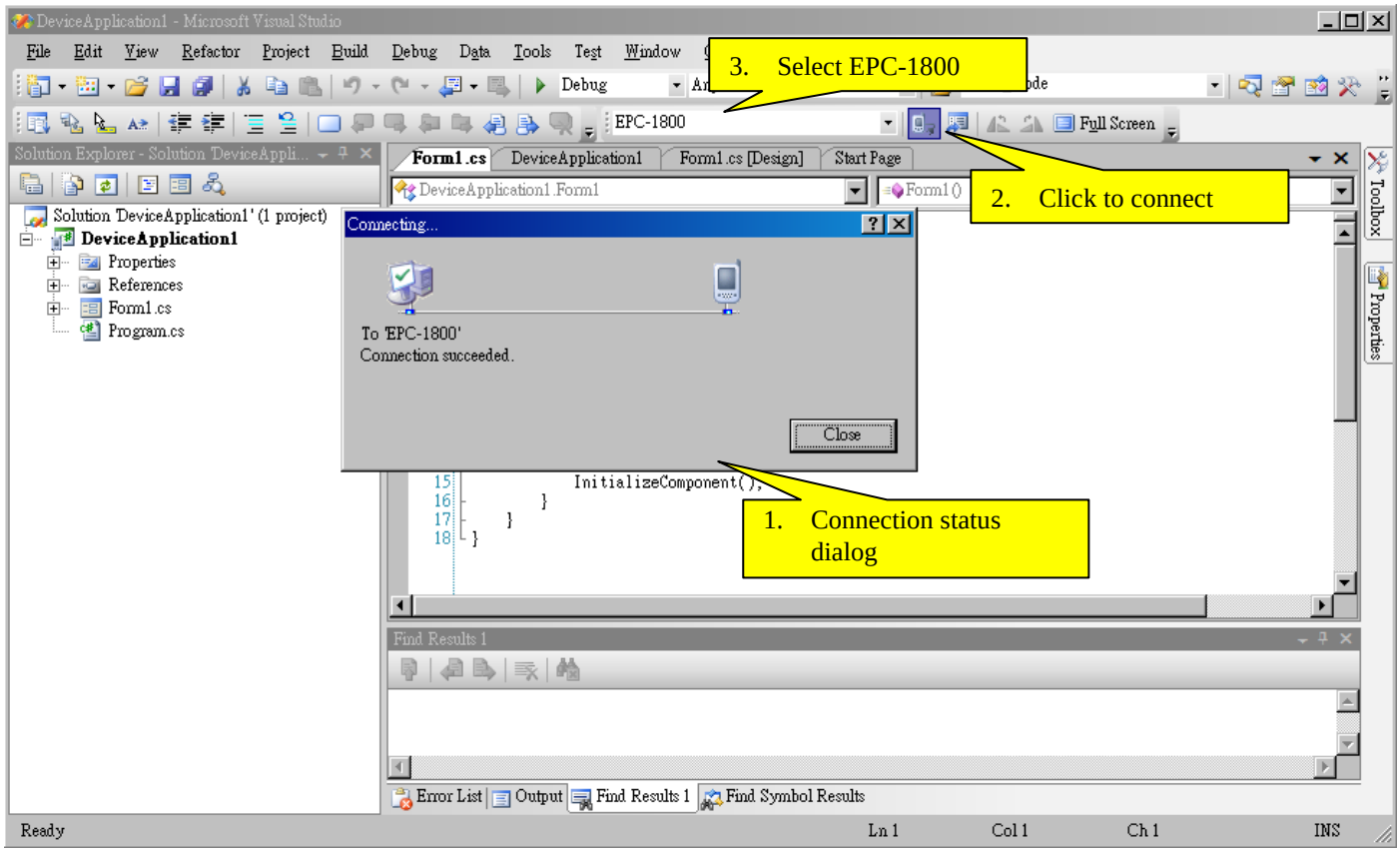


Figure 6-6: sequence to connect to SmartPAC

Also users could select hit the “Close” button to disconnect from EPC-1800 as well.

9. Start debugging as illustrated in the following figure.

   Note.

   1. Press the button indicated as the 1st circle to start debugging.
   2. Users could set breakpoints as show in the 2nd circle.
   3. The 3rd circle is the watch window. Users can monitor variables in this frame.

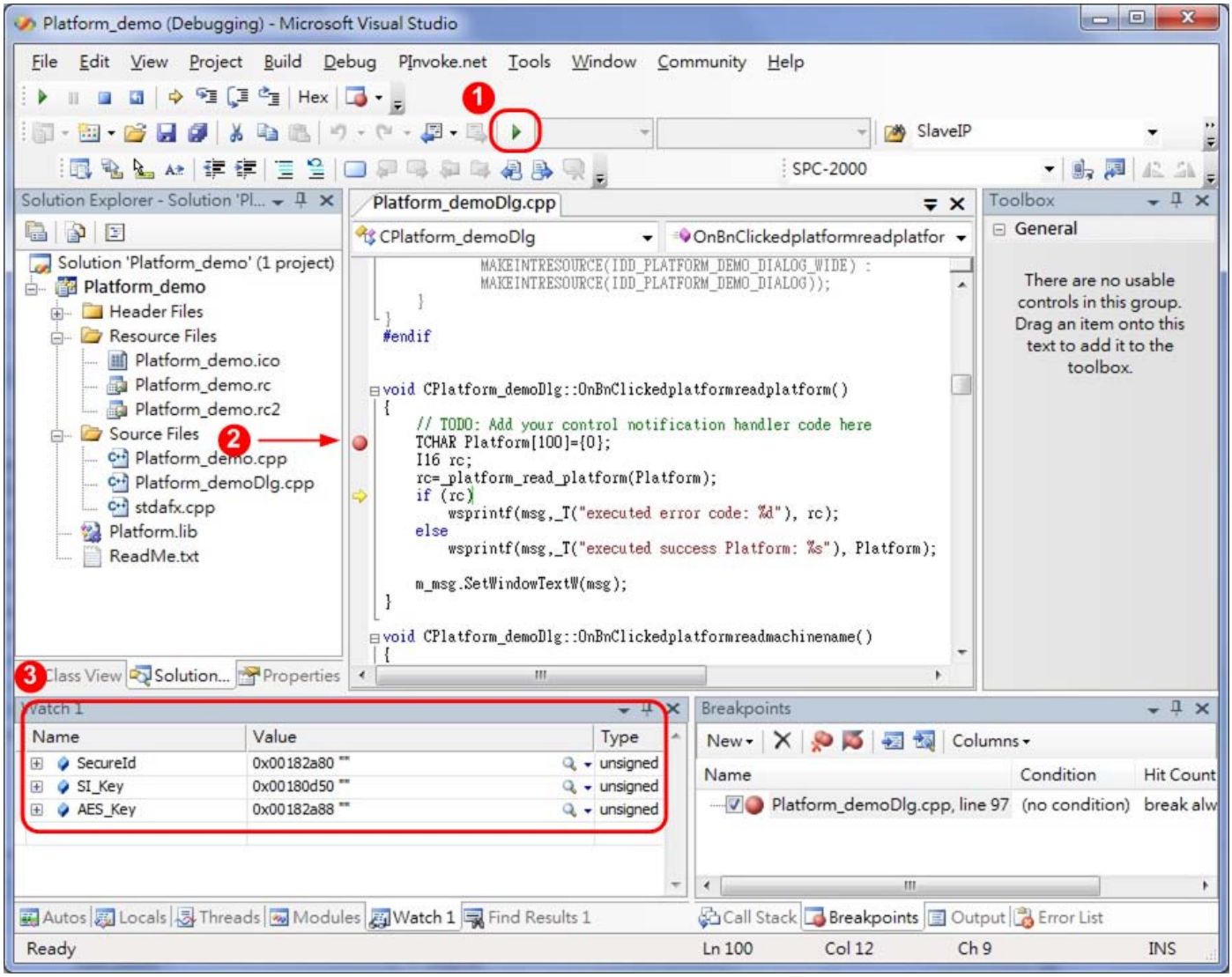


Figure 6-7: the debugging window

7. Function Reference

7.1. Hardware Initialization

The program starts with initialization of the EPC-1800 hardware. If the system needs to use the Motionnet functions, it is necessary to link the library by calling _ezpac_link_mnet(). After linking the library, users also need to do a reset and start the Ring by calling _mnet_reset_ring(ring_number) and _mnet_start_ring(ring_number) correspondingly.

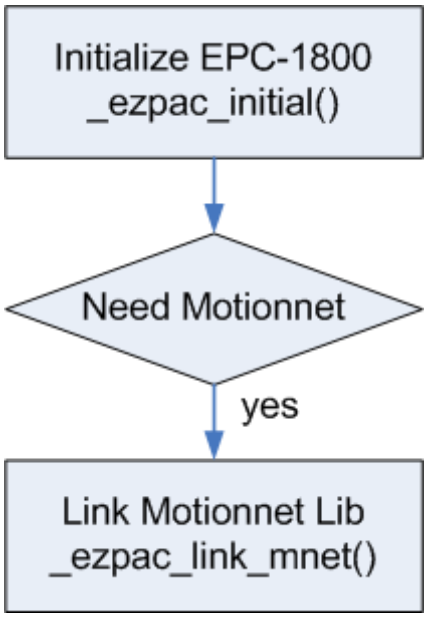


Figure 7-1: hardware initialization interface

7.2. Library Initialization

Motionnet library can be initialized by hardware the device driver library call. With the Linkage between the hardware and function library, the user can use different types of communication masters by the same software interface.

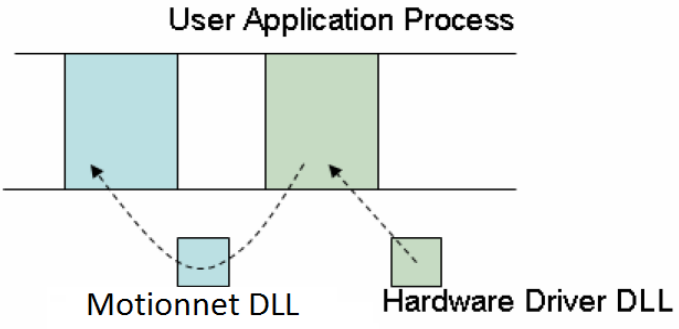


Figure 7-2: library relationship

7.3. Motionnet Master

The operation of Motionnet extension is divided into the following 2 groups. One is the Motionnet master device, the other is the slave device.

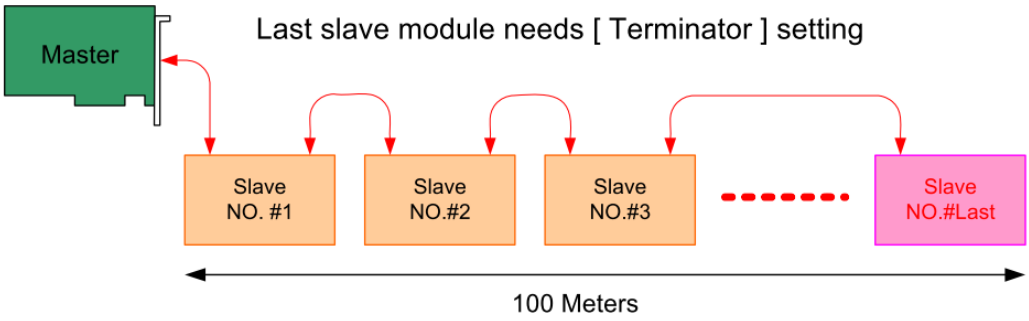


Figure 7-3: illustration of master-slave

7.4. Data Definition

Type	Description	Range
U8	8-bit ASCII character	0 to 255
I16	16-bit signed integer	-32768 to 32767
U16	16-bit unsigned integer	0 to 65535
I32	32-bit signed long integer	-2147483648 to 2147483647
U32	32-bit unsigned long integer	0 to 4294967295
F32	32-bit single-precision floating-point	-3.402823E38 to 3.402823E38
F64	64-bit double-precision floating-point	-1.797683134862315E308 to 1.797683134862315E309
Boolean	Boolean logic value	TRUE, FALSE

7.5. Platform Functions

7.5.1. Platform Information Functions

Function name	Description
_ezpac_initial	Initialize EPC-1800 platform.
_ezpac_get_device_type	Retrieve the type of the platform. It will return EPC-1800 for this case.
_ezpac_beep	Set the buzzer on for specified time.
_ezpac_beep_start	Turn on or off the buzzer.
_ezpac_read_rotary_switch_1	Read the number of the rotary switch.

7.5.1.1 _ezpac_initial

Description:

Initialize EPC-1800 platform

Syntax:

I16 _ezpac_initial()

Argument:

None

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.1.2 _ezpac_get_device_type

Description:

Retrieve the type of the platform. It will return EPC-1800 for this case.

Syntax:

I16 _ezpac_get_device_type(U8* Type)

Argument:

[input]	U8* Type	Return the type of the controller.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.1.3 _ezpac_beep

Description:

Set the buzzer on for specified time.

Syntax:

I16 _ezpac_beep(U32 Duration)

Argument:

[output]	U32 Duration	Duration that the buzzer is set to on.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.1.4 _ezpac_beep_start

Description:

Turn on or off the buzzer.

Syntax:

I16 _ezpac_beep_start(U8 OnOff)

Argument:

[output]	U8 OnOff	Set on or off of the buzzer.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.1.5 _ezpac_read_rotary_switch_1

Description:

Read the number of the rotary switch.

Syntax:

I16 _ezpac_read_rotary_switch_1(U8 *Val)

Argument:

[input]	U8 *Val	The number of the rotary switch.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.2. Platform I/O Functions

Function name	Description
_ezpac_get_led0	Get the status of LED 1
_ezpac_set_led0	Set the status of LED 1
_ezpac_get_led3	Get the status of LED 2
_ezpac_set_led3	Set the status of LED 2
_ezpac_read_lio	Read local DI

7.5.2.1 _ezpac_get_led0

Description:

Get the status of LED 1

Syntax:

I16 _ezpac_get_led0(U8* OnOff)

Argument:

[input]	U8 *OnOff	Return the status of LED 1.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.2.2 _ezpac_set_led0

Description:

Set the status of LED 1

Syntax:

I16 _ezpac_set_led0 (U8 OnOff)

Argument:

[Output]	U8 Data	Set the value of LED 1.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.2.3 _ezpac_get_led3

Description:

Get the status of LED 2

Syntax:

I16 _ezpac_get_led3(U8* OnOff)

Argument:

[input]	U8* OnOff	Return the status of LED 2.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.2.4 _ezpac_set_led3

Description:

Set the status of LED 2

Syntax:

I16 _ezpac_set_led3(U8 OnOff)

Argument:

[output]	U8 Data	Set the value of LED 2.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.2.5 _ezpac_read_lio

Description:

Read local DI.

Syntax:

I16 _ezpac_read_lio(U8* Val)

Argument:

[input]	U8* Val	Return the status of local DI

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.3. Motionnet Related Functions

Function name	Description
_ezpac_link_mnet	Activate the Motionnet master.
_ezpac_get_mnet_baud_rate	Get the baud rate of the Motionnet master.
_ezpac_set_mnet_baud_rate	Set the baud rate of the Motionnet master.

7.5.3.1 _ezpac_link_mnet

Description:

Activate the Motionnet master.

Syntax:

I16 _ezpac_link_mnet ()

Argument:

None

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.3.2 _ezpac_get_mnet_baud_rate

Description:

Get the baud rate of the Motionnet master.

Syntax:

I16 _ezpac_get_mnet_baud_rate (U16 RingNo, U8* BaudRate)

Argument:

[output]	U16 RingNo	Specify the ring number of the master. For EPC-1800 and EPC-1801, it is 0. For EPC-1821, it can be 0 and 1.
[input]	U8* BaudRate	The current baud rate.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.3.3 _ezpac_set_mnet_baud_rate

Description:

Set the baud rate of the Motionnet master.

Syntax:

I16 _ezpac_set_mnet_baud_rate (U16 RingNo, U8 BaudRate)

Argument:

[output]	U16 RingNo	Specify the ring number of the master. For EPC-1800 and EPC-1801, it is 0. For EPC-1821, it can be 0 and 1.
[output]	U8* BaudRate	The baud rate to be set.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.4. Platform AES Functions

Function name	Description
_ezpac_get_secure_id	Get the SECURE_ID of the system in 8 bytes array format.
_ezpac_generate_aes_key	Generate the AES_KEY with SI_KEY and SECURE_ID.
_ezpac_verify_aes_key	Check the validity of the generated AES_KEY.

7.5.4.1 _spc2_get_secure_id

Description:

Get the SECURE_ID of the system in 8 bytes array format.

Syntax:

I16 _ezpac_get_secure_id (U8 SecureID[8])

Argument:

[input]	U8 SecureID[8]	Pointer to an 8-byte array indicating the Secure ID. If SecureId is not null, the data read from security ASIC will be used to generate AES_KEY.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.4.2 _ezpac_generate_aes_key

Description:

Generate the AES_KEY with SI_KEY and SECURE_ID.

Syntax:

I16 _ezpac_generate_aes_key (U8 SI_Key[16], U8 SecureID[8], U8 AES_Key[16])

Argument:

[output]	U8 SI_KEY[16]	Pointer to a 16-element byte-array indicating SI key.Every element is an integer ranged from 0 to 9.
[output]	U8 SecureId[8]	Input the 8-byte array indicating the Secure ID.
[input]	U8 AES_KEY[16]	The generated AES_KEY in 16-byte array format.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.4.3 _ezpac_verify_aes_key

Description:

Check the validity of the generated AES_KEY.

Syntax:

I16 _ezpac_verify_aes_key (U8 SI_Key[16], U8 AES_Key[16], U8* Validity)

Argument:

[output]	U8 SI_KEY[16]	Pointer to a 16-element byte-array indicating SI key.Every element is an integer ranged from 0 to 9.
[output]	U8 AES_KEY[16]	Input the 16-byte array indicating the AES_KEY.
[input]	U8 *Validity	The result of the checking. 0: invalid，1: valid

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

AES Key Example:

```
U8 SID[8];
U8 SIK[16] = {1,2,3,4,5,6,7,8,9,0,1,2,3,4,5,6};    //every element is an integer ranged from 0 to 9
U8 AesKey[16];
U8 Validity;

// Generate AES Key
_ezpac_initial();
_ezpac_get_secure_id(SID);
_ezpac_generate_aes_key(SIK, SID, AesKey);

// Check AES Key
_ezpac_verify_aes_key(SIK, AesKey, ref Validity);
```

Secure ID Array

09	e8	1b	f6	05	00	00	05
[7]	[6]	[5]	[4]	[3]	[2]	[1]	[0]

SI Key Array

1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6
[15]	[14]	[13]	[12]	[11]	[10]	[9]	[8]	[7]	[6]	[5]	[4]	[3]	[2]	[1]	[0]

AES Key Array

9507	f73e	8bb9	5a78	d4a7	48dc	bb4a	537b
[15][14]	[13][12]	[11][10]	[9][8]	[7][6]	[5][4]	[3][2]	[1][0]

7.5.5. Platform Retain Functions

Function name	Description
_ezpac_read_fram_byte	Read a byte data from a retainable memory.
_ezpac_read_fram_word	Read a word data from a retainable memory.
_ezpac_read_fram_dword	Read a double word data from a retainable memory.
_ezpac_write_fram_byte	Write a byte data to a retainable memory.
_ezpac_write_fram_word	Write a word data to a retainable memory.
_ezpac_write_fram_dword	Write a double word data to a retainable memory.

7.5.5.1 _ezpac_read_fram_byte

Description:

Read a byte data from a retainable memory.

Syntax:

I16 _ezpac_read_fram_byte(U16 Offset, U8* Val)

Argument:

[output]	U16 Offset	Specify the offset the retainable memory.
[input]	U8* Val	Return the value of the retainable memory.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.5.2 _ezpac_read_fram_word

Description:

Read a word data from a retainable memory.

Syntax:

I16 _ezpac_read_fram_word(U16 Offset, U16* Val)

Argument:

[output]	U16 Offset	Specify the offset the retainable memory.
[input]	U16* Val	Return the value of the retainable memory.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.5.3 _ezpac_read_fram_dword

Description:

Read a double word data from a retainable memory.

Syntax:

I16 _ezpac_read_fram_dword(U16 Offset, U32* Val)

Argument:

[output]	U16 Offset	Specify the offset the retainable memory.
[input]	U32* Val	Return the value of the retainable memory.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.5.4 _ezpac_write_fram_byte

Description:

Write a byte data to a retainable memory.

Syntax:

I16 _ezpac_write_fram_byte(U16 Offset, U8 Val)

Argument:

[output]	U16 Offset	Specify the offset the retainable memory.
[output]	U8 Val	Set the value of the retainable memory.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.5.5 _ezpac_write_fram_word

Description:

Write a word data to a retainable memory.

Syntax:

I16 _ezpac_write_fram_word(U16 Offset, U16 Val)

Argument:

[output]	U16 Offset	Specify the offset the retainable memory.
[output]	U16 Val	Set the value of the retainable memory.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

7.5.5.6 _ezpac_write_fram_dword

Description:

Write a double word data to a retainable memory.

Syntax:

I16 _ezpac_write_fram_dword(U16 Offset, U32 Val)

Argument:

[output]	U16 Offset	Specify the offset the retainable memory.
[output]	U32 Val	Set the value of the retainable memory.

Return:

PLATFORM_NoError	The API is successfully returned.
Others	Please refer to the error code table at Appendix A.

8. Appendix A

8.1. The Platform Error Code List Table

PLATFORM_NoError	0
PLATFORM_NotReady_Error	-9000
PLATFORM_CheckDeviceNotMatch_Error	-9001
PLATFORM_Unknown_Error	-9005
PLATFORM_DeviceUnknown_Error	-9006
PLATFORM_Version_Error	-9010
PLATFORM_Open_File_Error	-9011
PLATFORM_Write_File_Error	-9012
PLATFORM_Read_File_Error	-9013
PLATFORM_Out_Of_Range_Error	-9020
PLATFORM_InvalidParameter_Error	-9021
PLATFORM_GetSecureIdFailed_Error	-9022
PLATFORM_GenAesKeyFailed_Error	-9023
PLATFORM_InformationType_Unknown_Error	-9030
PLATFORM_Debug_Infomation_0	-9040
PLATFORM_Debug_Infomation_1	-9041
PLATFORM_Debug_Infomation_2	-9042
PLATFORM_Debug_Infomation_3	-9043
PLATFORM_NotSucceed_Error	-9090

8.2. The Motion Error Code List Table

ERR_NoError	0
ERR_BoardNotInitYet	-14001
ERR_BoardInitializedAlready	-14002
ERR_InvalidBoardNumber	-14003
ERR_InvalidAxisNumber	-14004
ERR_InvalidParameter1	-14011
ERR_InvalidParameter2	-14012
ERR_InvalidParameter3	-14013
ERR_InvalidParameter4	-14014
ERR_InvalidParameter5	-14015
ERR_InvalidParameter6	-14016
ERR_InvalidParameter7	-14017
ERR_InvalidParameter8	-14018
ERR_InvalidParameter9	-14019
ERR_InvalidParameter10	-14020
ERR_InvalidParameter11	-14021
ERR_InvalidParameter12	-14022
ERR_SlowDownPointError	-14031
ERR_Err3PointsInput	-14032
ERR_GetCenterFailed	-14033
ERR_CompareBufferFull	-14034
ERR_AxisNotStoppedYet	-14035